

NGST Architecture Trade Studies
and
Project Quarterly Review
OTA Thermal Analyses/Results Summary

Greg Schunk
MSFC/ED63
(205)544-7221
richard.g.schunk@msfc.nasa.gov

OTA Thermal Analyses/Results Summary

Agenda

- Thermal Modeling Approach
- OTA Thermal Model Configurations
- Steady State Results
- Transient Slew Analyses
- Truss Heat Leak Parametric Analysis
- Secondary Mirror Mast Trade
- Summary/Future Plans

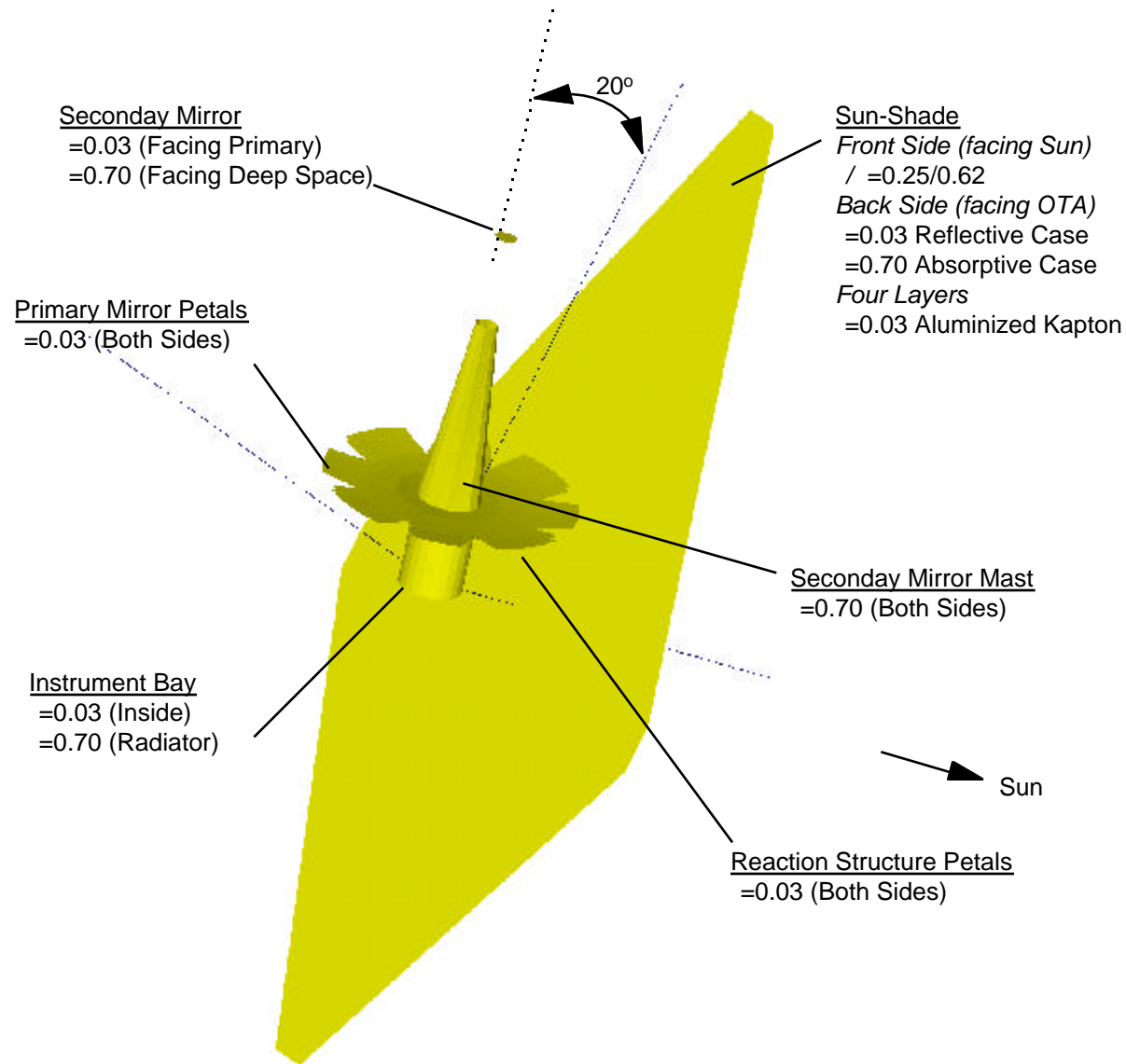
OTA Thermal Analyses/Results Summary

Thermal Modeling Approach

- Utilized an in-house computer program to convert NASTRAN geometry data to TRASYS/SINDA format.
 - NASTRAN triangle and quadrilateral elements converted to TRASYS polygons.
 - NASTRAN bar elements converted to cylindrical TRASYS struts with SINDA conductors based upon cross sectional area.
 - NASTRAN FEM mesh converted to mathematically equivalent SINDA conductor network.
 - Able to provide a 1-to-1 correspondence between NASTRAN and SINDA nodes.
- Steady State/Transient TRASYS/SINDA models
 - Models include thermal conductance within the mirror, secondary mirror mast, and support structure
 - Radiation exchange between all surfaces is included.
 - Thermal path between mirror and support structure through actuators is included in the models.
 - Thermal path between mirror petals and mirror center section through hinges is included
 - Transient models include the thermal mass of the mirror

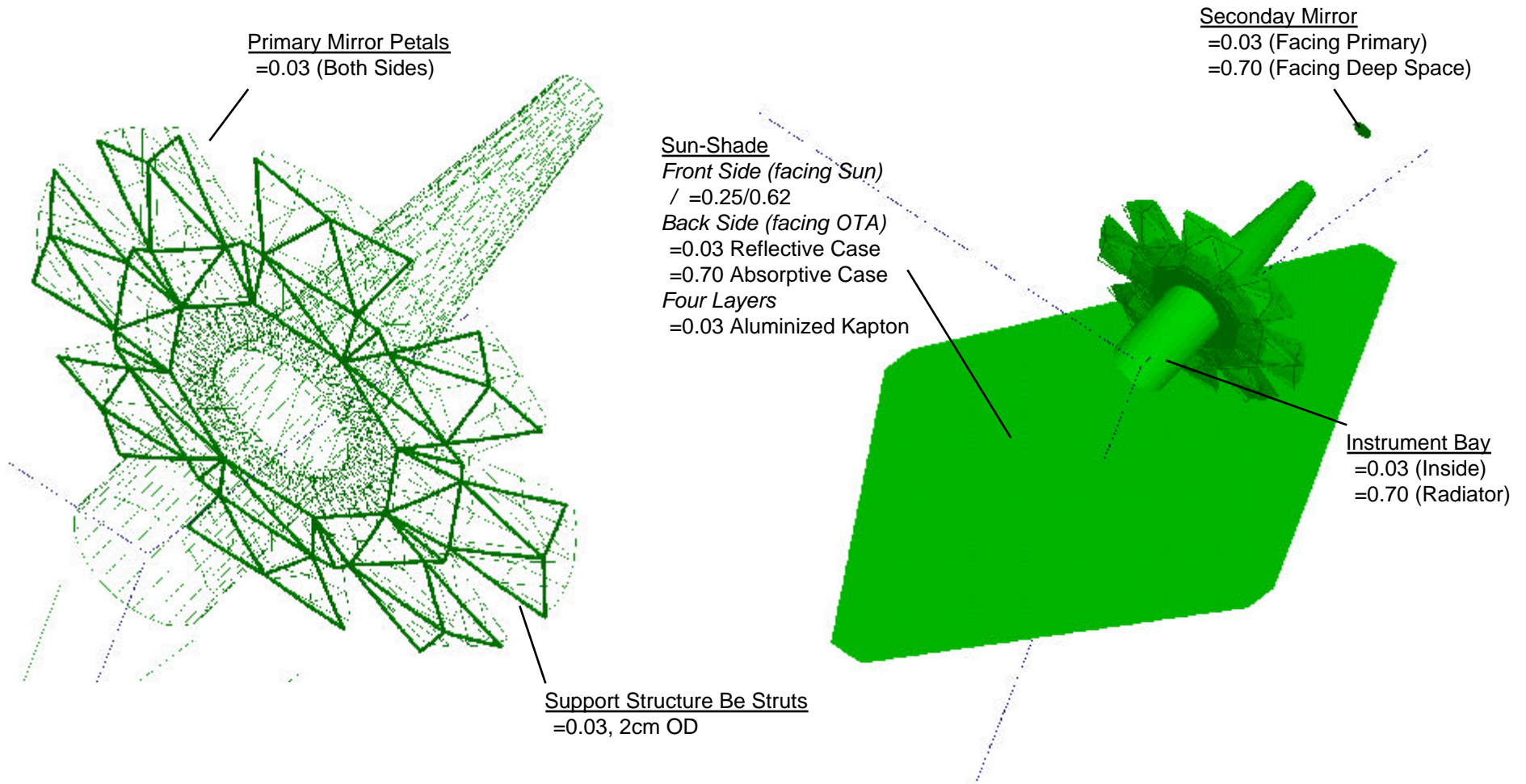
OTA Thermal Analyses/Results Summary

OTA Configuration #1 - Be Mirror/Graphite Epoxy Support Structure with Aluminum Close-out



OTA Thermal Analyses/Results Summary

OTA Configurations #2 and #4 - Be Mirror/Be Support Structure with No Close-out



OTA Thermal Analyses/Results Summary

Thermal Model Configurations

	Mirror Material	Support Structure Material	Reaction Structure Close-out Panel	Sunshade Model
Configuration #1	Beryllium	Graphite-Epoxy	Aluminum	Constructed from GSFC design data ¹
Configuration #2	Beryllium	Beryllium	None	Constructed from GSFC design data ¹
Configuration #3	Beryllium	Beryllium	Beryllium	Constructed from GSFC design data ¹
Configuration #4	Beryllium	Beryllium	None	Furnished by GSFC ²

¹TRASYS model constructed from geometry data furnished by Chuck Perrygo/Swales and from optical property data furnished by Mike Choi/GSFC

²TRASYS/TSS models of innermost sunshade layer and boundary temperatures provided by Mike Choi/GSFC and Dave Neuberger/Swales

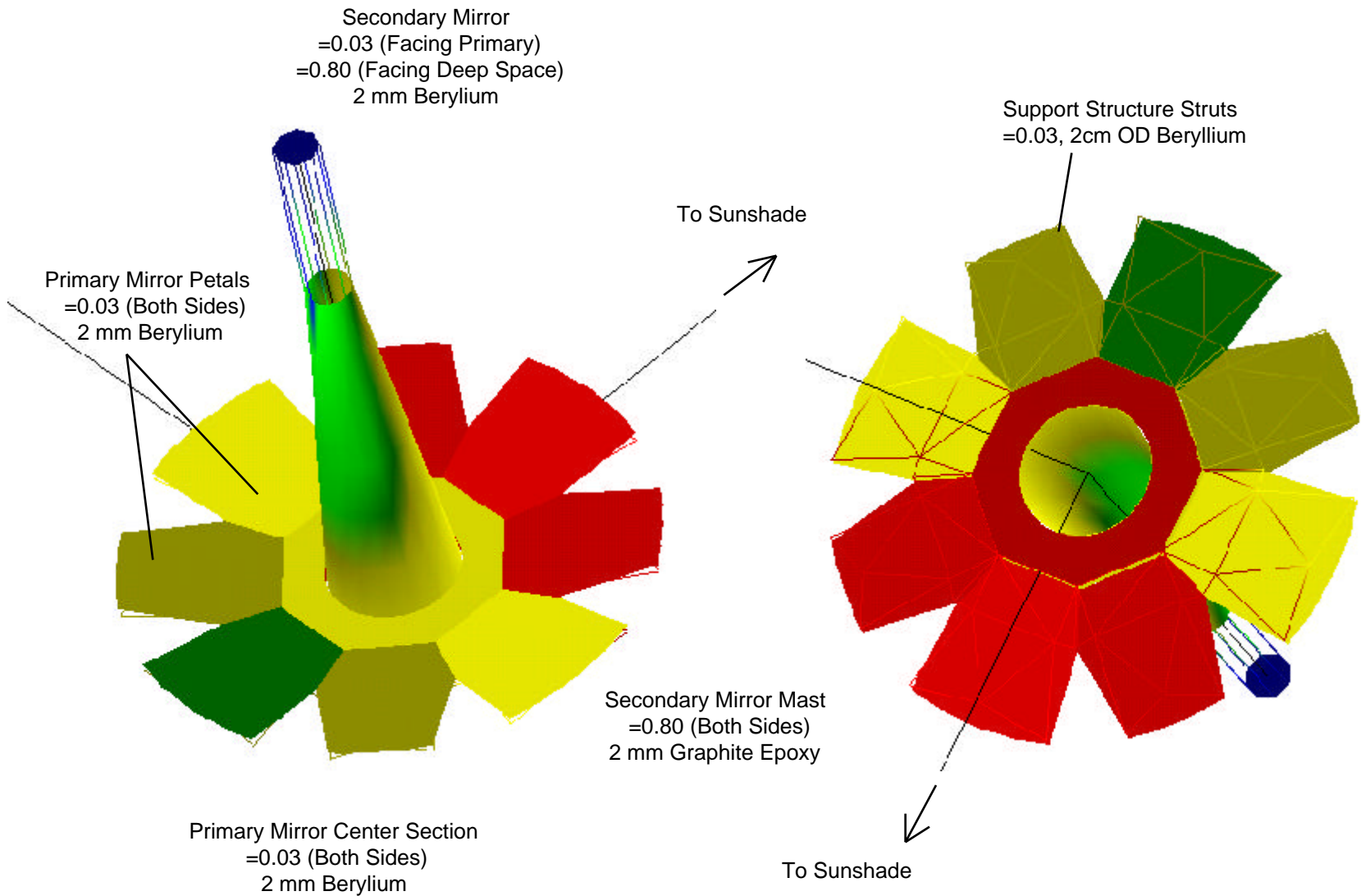
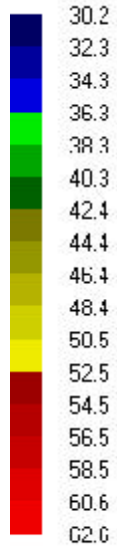
OTA Thermal Analyses/Results Summary

Steady State Thermal Analysis Summary

	Mirror/ Support/ React Material	Leading Edge Mirror Temperature (K)	Trailing Edge Mirror Temperature (K)	Delta Temperature (K)
Configuration #1	Be/Graphite Epoxy/Al	57.95	33.87	24.08
Configuration #2	Be/Be/None	58.26	40.22	18.04
Configuration #3	Be/Be/Be	54.91	29.56	25.35
Configuration #4	Be/Be/None	47.65	17.67	29.98

NGST OTA Steady State Thermal Model Results (Configuration #2 Be-Be Mirror/React Struct, Reflective Sunshade =0.03)

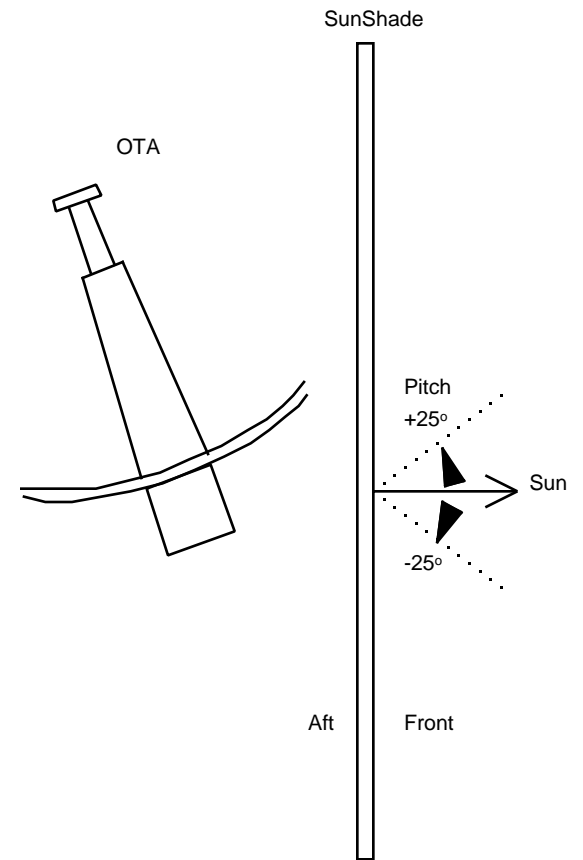
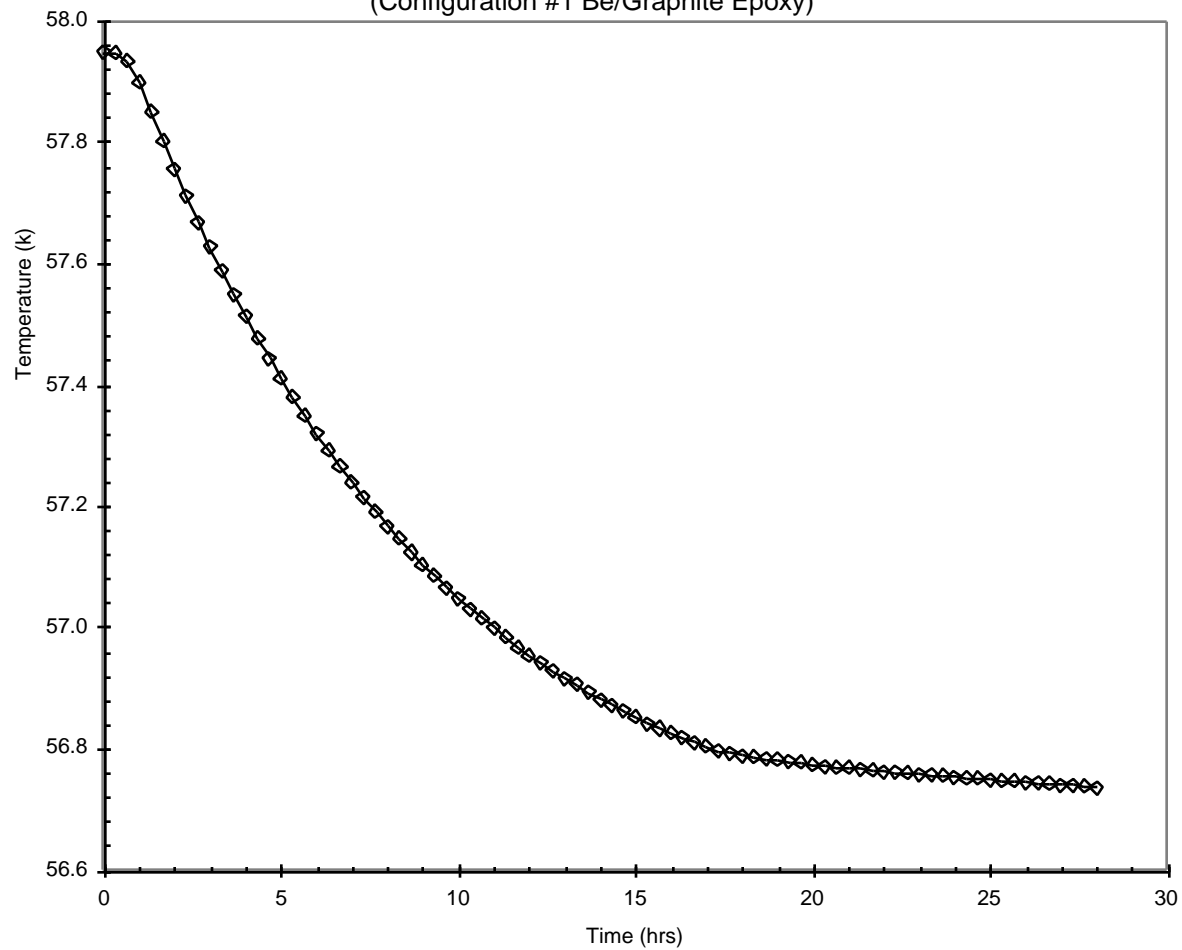
Temp (K)



OTA Thermal Analyses/Results Summary

Transient Slew Analysis

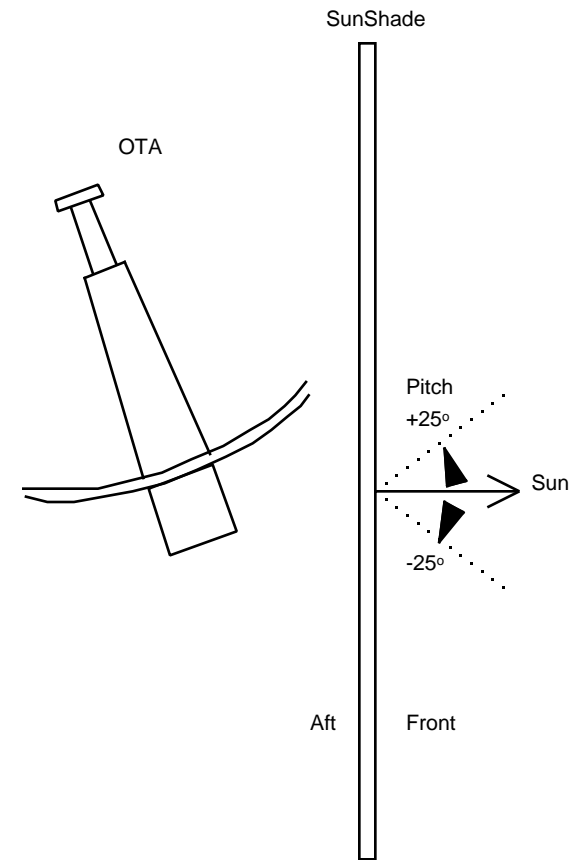
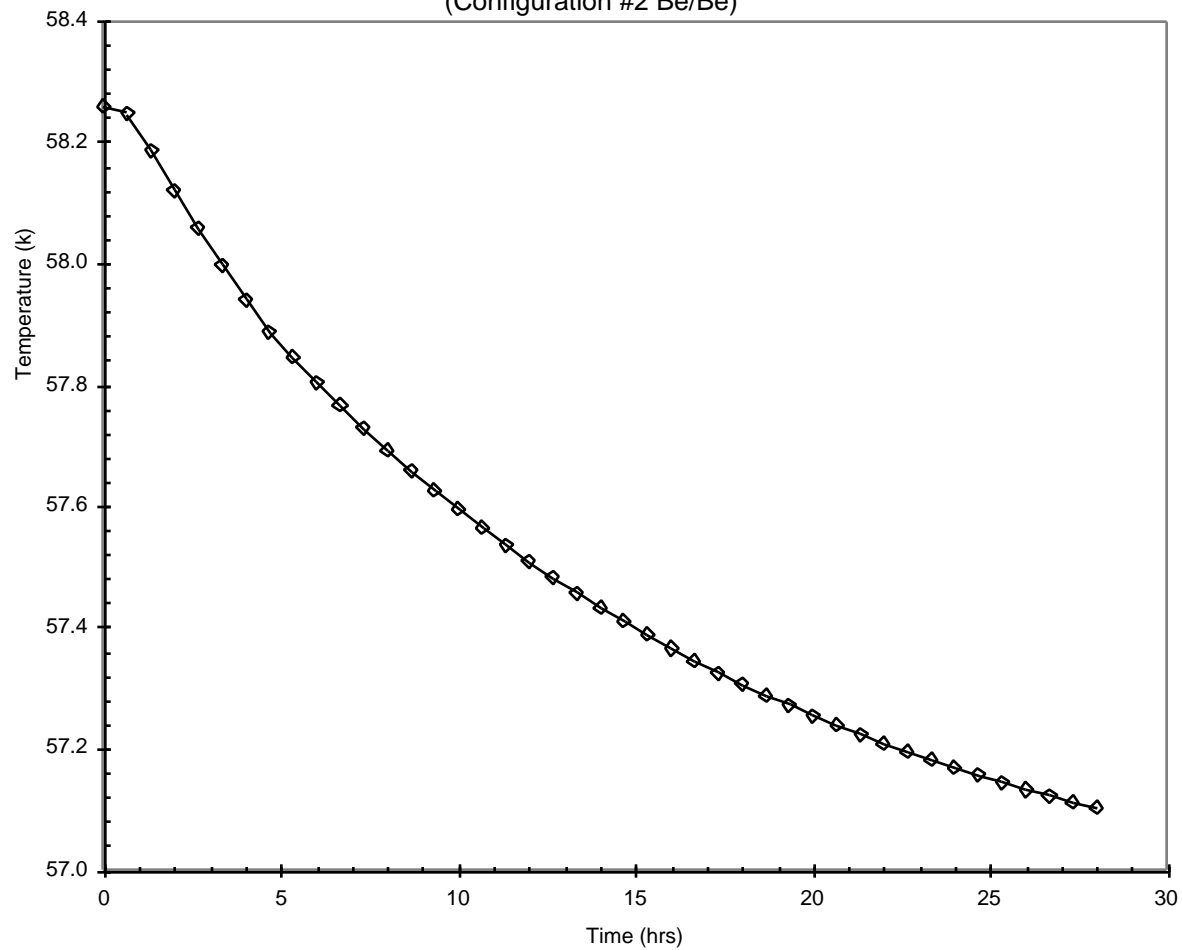
Transient Response of Leading Edge Mirror Temperature
following a One Hour Slew between 0 and 25 deg
(Configuration #1 Be/Graphite Epoxy)



OTA Thermal Analyses/Results Summary

Transient Slew Analysis

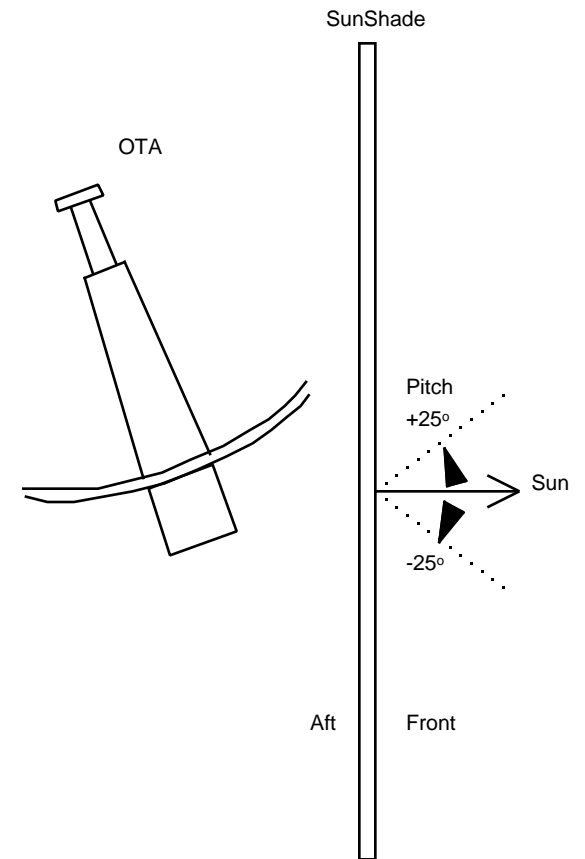
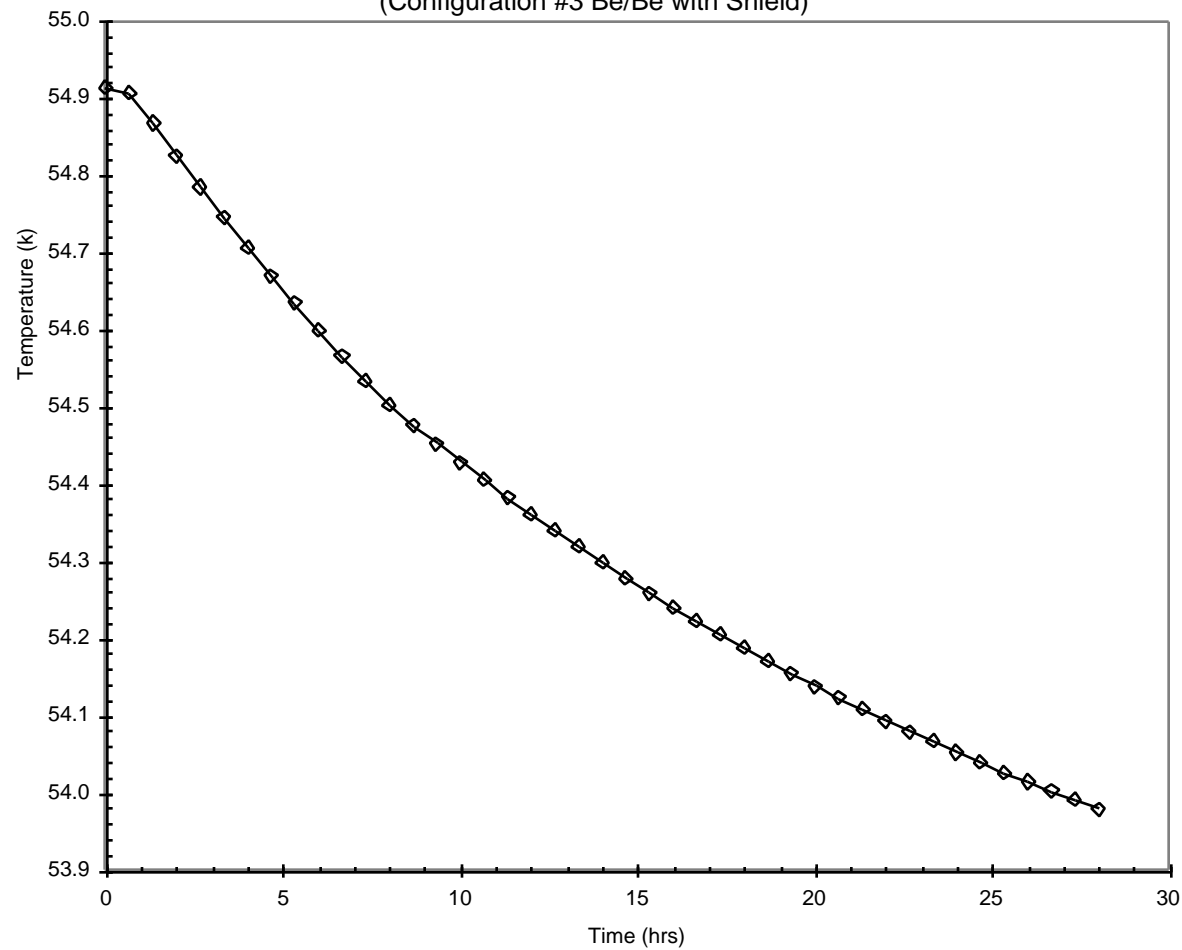
Transient Response of Leading Edge Mirror Temperature
following a One Hour Slew between 0 and 25 deg
(Configuration #2 Be/Be)



OTA Thermal Analyses/Results Summary

Transient Slew Analysis

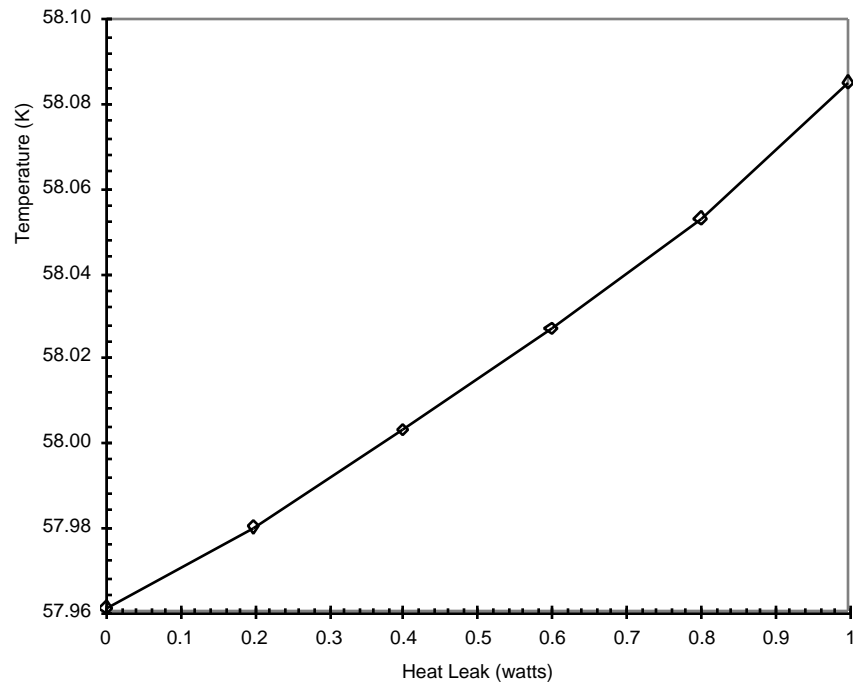
Transient Response of Leading Edge Mirror Temperature
following a One Hour Slew between 0 and 25 deg
(Configuration #3 Be/Be with Shield)



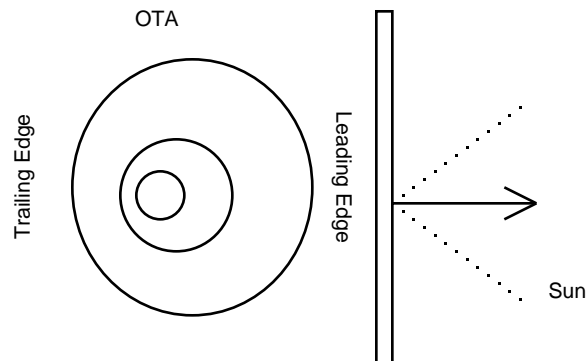
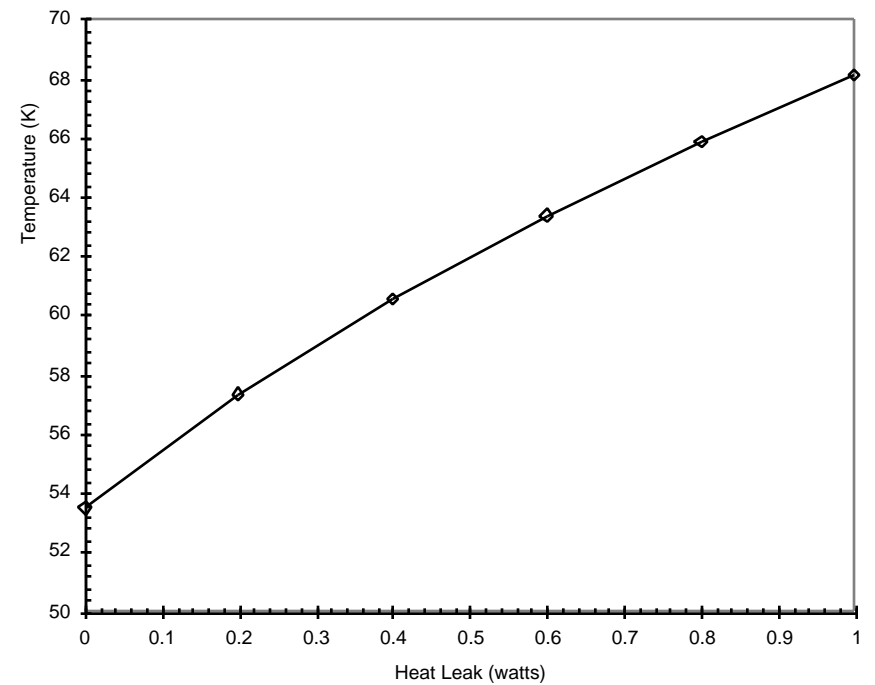
OTA Thermal Analyses/Results Summary

Truss Heat Leak Parametric Analysis

Mirror Leading Edge Temperature versus Heat Leak thru Truss



Science Instrument Module Average Temperature versus Heat Leak thru Truss

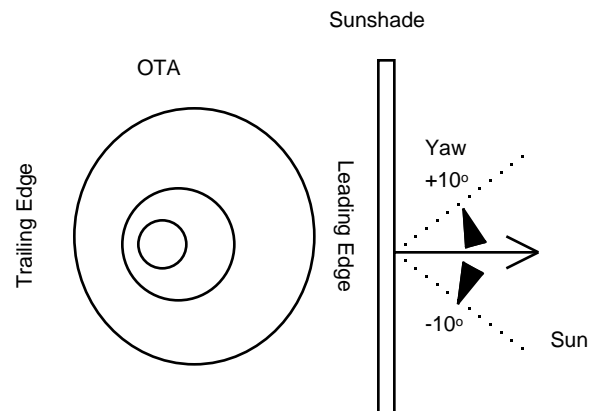


OTA Thermal Analyses/Results Summary

OTA Secondary Mirror Mast Trade Study Configuration #1 Be-Graphite Epoxy Mirror-React Struct

Pitch=0°, Yaw=0°, Reflective Sunshade (/ =0.25/0.62)

	Secondary Mirror Mast No Conductive Straps	Secondary Mirror Mast Conductive Straps	No Secondary Mirror Mast No Conductive Straps	No Secondary Mirror Mast Conductive Straps
Leading Edge Petal (K)	57.949	54.081	57.353	53.736
Trailed Edge Petal (K)	33.826	40.127	37.477	41.990
Temperature Difference	24.123	13.954	19.876	11.746



OTA Thermal Analyses/Results Summary

Summary/Future Plans

- Summary
 - Unoptimized mirror gradient > 18 K in all cases
 - Lower predicted sunshade temperatures from GSFC TSS analysis result in much lower primary mirror temperatures
 - Thermal gradients present in open support structure members (configurations #2 and #4) may not be acceptable
 - > 25 hours required to reach steady state following slew
 - Truss heat leak < 1 watt appears to be manageable; higher fidelity science instrument module/truss model required to accurately determine
- Future Plans
 - Glass mirror thermal analyses
 - Optimization of primary mirror thermal gradient
 - Refine existing analyses with updated sun-shade model(s)
 - Refine truss heat leak analyses with higher fidelity science instrument module model
 - Actuator dissipation transient analysis